



NASA STTR 2006 Phase I Solicitation

T1 Ames Research Center

Ames Research Center stands at the epicenter of the most prolific and prosperous cluster of high technology businesses, universities, and research laboratories in the world. Ames is internationally recognized as a pre-eminent research institution with an enduring research culture. Innovative design concepts and breakthrough technologies developed here over the last 60 years are legendary. They include the blunt body concept, the first manmade object to leave the Solar System (Pioneer), the supersonic area rule, hypersonic ranges, arc jets, the chemical origins of life, computational fluid dynamics, massively parallel computing, air traffic management, airborne science, exploration of the outer planets, infrared astronomy, and the discovery of water on the moon. Ames today seeks innovative breakthroughs in a 21st Century arena. Ames' pioneering research in information technology, biotechnology, and nanotechnology will enable development of innovative sensors to probe Earth, other planets, and other solar systems, and dramatically increase the ability to communicate large volumes of information across space. It could also lead to stronger materials, ultra-small electronic devices, and new space missions with lower-weight components requiring less power and fuel. With leading-edge capabilities in high-end computing, Ames can fully exploit these emerging technologies and interdisciplinary research, which many see as the most likely source of breakthrough technologies in the coming decades.

Subtopics

T1.01 Information Technologies for System Health Management, Autonomy, and Scientific Exploration

Lead Center: ARC

Center: ARC

Information technology is a key element in the successful achievement of NASA's strategic goals. Modern tools and techniques have the capability to redefine many design and operational processes as well as enable grand exploration and science investigations. This subtopic seeks innovative solutions to the following information technology challenges:

- Onboard methods that monitor system health and then automatically reconfigure to respond to failures

and sustain progress toward high-level goals. Special emphasis will be on computational techniques for coordinating multi-agent systems in the presence of anomalies or threats. Proposals should focus on data analysis and interpretation rather than development of new sensors;

- Onboard, real-time health management systems that perform quickly enough to monitor a flight control system (including spacecraft and fixed or rotary wing aircraft) in a highly dynamic environment and respond to anomalies with suggested recovery or mitigation actions;
- Integrated software capabilities that allow automated science platforms, such as rovers, to respond to high-level goals. This could include perception of camera and other sensor data, position determination and path planning, science planning, and automated analysis of resulting science data;
- Data fusion, data mining, and automated reasoning technologies that can improve risk assessments, increase identification of system degradation, and enhance scientific understanding;
- Techniques for interconnecting and understanding large heterogeneous or multidimensional data sets or data with complex spatial and/or temporal dynamics;
- Computational and human/computer interface methodologies for inferring causation from associations and background knowledge for scientific, engineering, control, and performance analyses;
- Innovative communication, command, and control concepts for autonomous systems that require interaction with humans to achieve complex operations.

T1.02 Space Radiation Dosimetry and Countermeasures

Lead Center: ARC

Center: ARC

As NASA embarks on its Exploration agenda the study of the Cosmic, Solar, Lunar, and Van Allen Belt space radiation environments will continue to guide new biologically related innovation and mitigation needs at NASA. Understanding Space Radiation induced effects on biological organisms is a vital component for future manned spaceflight mission success. Development of support technologies to protect astronaut crew health will be essential for successful long-term mission operations. Our current understanding of the space radiation environment interaction with humans, space rated materials, and technological systems is limited. Specifically, information on radiation events with high atomic number, high energy particles (HZE particles), and energetic protons is lacking compared to our understanding of gamma and x-rays. NASA has established a space radiation laboratory at Brookhaven National Labs capable of generating HZE particles and protons. NASA also supports a facility at Loma Linda University Medical Center capable of generating energetic protons to enable research studies and technology development. NASA is seeking innovative technologies in the areas described below.

Advanced Space Radiation Dosimeters

NASA seeks the development of a small, low power suite of dosimeters to measure the biologically significant range of space radiation on board manned spacecraft, planetary habitats, or on astronaut extravehicular activity (EVA) suits. The devices must be able to measure the absorbed dose/linear energy transfer (LET) based dose equivalent from electrons, photons (X-rays and gamma rays), protons, heavy ions (HZE) and secondary neutrons.

Both real-time dose/dose equivalent rate and cumulative dose/dose equivalent over selected time intervals, e.g. a day or a mission, are required, along with an alarm system based on fluence rate, dose rate, or cumulative dose (e.g. during Solar Particle Events). The suite of dosimeters should provide time resolved LET data or a suitable surrogate (e.g. lineal energy (y) as measured by a gas filled microdosimeter) and have embedded linear energy transfer-based quality factor algorithms for determining dose equivalent. The devices should be sensitive down to 0.05 milliGray/0.1 mSv and should be able to measure a maximum dose of 1 Gy/3 Sv. The LET of charged particles of interest ranges from 0.2 keV/ μm to 1000 keV/ μm . The National Council on Radiation Protection and Measurements Report 142 includes a detailed description of the radiation field to be assessed for radiation protection of astronauts. NASA acknowledges the difficulty in measuring secondary neutrons from interactions of protons and heavy ions with spacecraft structures and has particular interest in this area. If possible, the response of candidate dosimeters to protons, heavy ions, and neutrons should be characterized. For absorbed dose calibrations, the devices should be calibrated to National Institute of Standards and Technology (NIST) traceable absorbed dose standards. Prototype hardware or technology developed must be capable of being converted to robust and reliable space flight hardware in the future. This means that all hardware and software must be capable of being fully documented in the future, and that interface software must be compatible with current operating systems.

High Throughput Genomic Analysis Techniques

Following low dose irradiation of cells by protons and heavy ions, damage is localized to only a very few cells. The ability to separate cells with or without genetic changes in an automated manner is of interest. Current technologies are inefficient in identifying smaller-scale genetic changes (less than a million base-pairs (Mbp)) under these conditions. Technologies of interest are:

- Technologies to rapidly score small-scale genetic changes (1 Mbp) genetic changes to chromosomes following low dose irradiation;
- Imaging techniques to rapidly identify with high accuracy undamaged cells from a cell population irradiated at low doses.

High Throughput Countermeasure Evaluation Techniques

NASA seeks the development of high throughput techniques for the evaluation of countermeasures that can be used by astronauts to ameliorate the effects of ionizing radiation in space, including Solar Particle Events, secondary radiation particle events, and continuous low dose radiation exposure. Techniques to evaluate currently available pharmaceuticals to counteract radiation effects are of interest.

